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IPC-3

User Manual

Version 1.2

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Document change history

Version	Date	Comments
1.0	Mar-19-08	First release
1.1	Apr-23-08	GPIO output default stage added. GPIO Pull up function (jumper) added. Interface circuit illustration diagram updated. Cinch-to-RJ45 conversion option added.
1.2	Jun-19-08	CE declaration of conformity and ESD precaution statement added.

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Hardware and electrical connections given in this manual are for illustration purposes only. Moneyflex Technologies LLC bears no responsibility of any damage or hazard that may cause.

Scope of this manual

This manual is to provide an overall view of the IPC products and IPC-3, in particular its architecture and operations. Should you find any part of the manual is missing or mistaken, please revert to us at email *tech@moneyflex.net*.

There are two more Moneyflex documents user will need before he / she can do the PC programming:

PG001-0 Programmer's Guide
K1 Protocol Specification

Other suggested reading material:

FTDI driver documents at *http://www.ftdichip.com/FTDocuments.htm*
Product manual of the respective peripherals

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1.0 INTRODUCTION

The Intelligent Protocol Communicator (IPC) series is a set of products designed to solve many of the connection and interface problems found in nowadays automated payment systems. No matter your money validating device utilizes an output format of a Simple Pulse, Dry relay contacts, a Parallel or Binary output, a MEI™ EBDS serial port, an ITL SSP® port, a NAMA® MDB / ICP daisy-chained bus system or the ccTalk bidirectional serial data line, IPC validates them all. With the introduction of IPC-3, the capability of IPC products extends to electrical switching, digital and analog inputs, power outputs and multi coin hopper controls.

IPC consolidates all the status and events happening in your peripherals and reports them in a systematic way back to your application. It utilizes the efficient *K-1 Protocol* for communication between your application and IPC device. This unifies different communication standards found in different peripherals into one easy to learn language.

IPC makes PC based vending machine, timed internet café and POS system work like a champ. With IPC working in your system, you can take all the guess works out of your cash and cashless payment system.

1.1 IPC-3 FEATURES

- USB 2.0 full speed connectivity
- Industrial standard controller chipset supports OSes such as:
  Windows 98, Me, 2K, XP, Vista, Linux, Mac OS 8, 9, X and more
- SDKs and Drivers for software developers
- Easy to use Moneyflex developed *K1 Protocol*
- 12 general purpose digital inputs and 12 general purpose digital outputs. Each output capable to sink 500mA and 1000mA (on Port 4) for inductive loading
- 4 coin hopper control ports, MK4 Mode 2 (parallel) compatible
- 4 general purpose analog input ADCs

1.2 TERMINOLOGY

Below listed the terminologies and their explanation that are widely used in this manual.

MFX	=Short for Moneyflex Technologies LLC.
PC	=Personal computer. An IBM x86 compatible machine.
OS, OSes	=PC operation system, systems.
Device	=IPC itself or a USB Device in general.
MCU, MCUs	=Micro-Processor(s) inside the device. Some devices may have multiple MCUs running together in parallel for parallel processing. A single MCU may house multiple Controllers within.
Controller	= An individual working unit that serves a particular function.

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Controller ID	= An unique Address ID in Hex format that the Controller is defined to.
Peripheral	= A functional unit attaches to IPC and is controlled by an IPC Controller.
User	= User's PC application program. For better readability, this manual adopts a male user gender and uses "he" instead of "it" to represent the program.
K1 Protocol	= MFX developed computer protocol adopted by IPC and other products.
Coin Hopper	= A electro-mechanical device that output coins.
ms	= millisecond(s). 1/1000th of a second.
us	= microsecond(s). 1/1000000th of a second.
USB-IF	= Universal Serial Bus Implementer Forum. www.usb.org
ADC	= Analog-to-Digital Converter. An electronic device to give digital values out of an analog voltage input.
MK4	= A universal coin hopper produced by Money Controls Ltd.

2.0 ARCHITECTURE

An IPC consists of one or more CPUs working together, called the MCUs to achieve parallel processing power. Each MCU has a number of different Controllers built into it. The Controller is the working unit that user is dealing with. When user is *talking* to IPC, he is actually *talking* to an individual Controller by using the *K1 Protocol*. The protocol enables user to specify which Controller the message is directed to. Only the intended Controller with a correct ID number will reply to the request. On top of that, there is a set of global commands that all Controllers will response to.

Each Controller has its own firmware known as the kernel. The kernel version can be retrieved by user at anytime in his application. By checking the kernel version, user can know the updated information about that particular Controller.

The USB controller used in IPC is a USB 2.0 full speed chipset conforms to USB 2.0 standard set by USB-IF. Its main function is to inter-connect all MCUs reside within the device and distribute user commands to/from the PC and Controllers.

2.1 KERNEL UPGRADE

Controllers' kernel is flash ROM based. Occasionally MFX will release a new kernel version for a particular controller for new features. This kind of upgrade can only be conducted at MFX appointed service site. Any attempt to tamper with the kernel program will lead to unit malfunction and void all warranties.

2.2 PC INSTALLATION

The procedure of a PC OS (eg. Windows) registers a USB device and gets it ready for use is called Enumeration. When a USB device plugs in to a USB port, OS receives the Vendor ID (VID) and Product ID (PID) from the device. By sorting out these two IDs, OS loads the correct driver files (*.inf) / system

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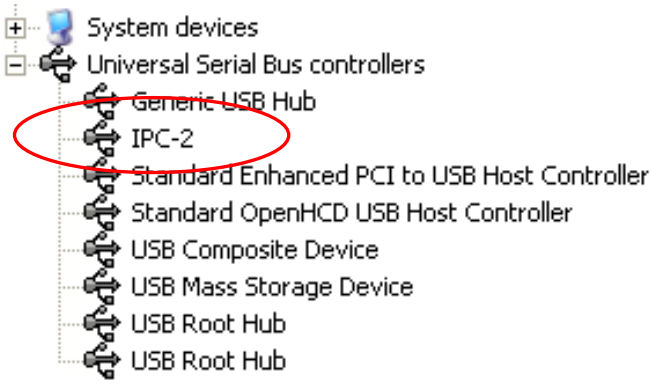
files (*.sys) / dynamic link library files (*.dll) / etc… The device is then assigned with a HandleID. Application program can uses this HandleID to access the device.

> ***Warning:*** ***Always use MFX provided device drivers for correct operation. Failure to do so will result in installation failure and/or OS crashing.***

Visit website *www.moneyflex.net* for latest driver options.

Upon successful enumeration, IPC is recognized as a Universal Serial Bus Controller.



Note: Actual product may have a different name

2.3 CODE DEVELOPMENT

For complete programming details, please refer to *PG001-0 Programmer Guide*. Here are some examples of *K1 Protocol*.

- DEVICE RESET, Global command
  This command resets all Controllers, including PC Supervisor within the Device. All setup parameters will need to re-install after this command.

- ADDRESS CLASH, Global command
  This command requests all Controllers within the Device to show their existence by replying with their respective Controller ID. In order to avoid multiple Controllers sending their ID at the same time, IPC adopts a timing scheme for this. The elapse time of each Controller to send its ID is based on its ID value multiplied by 5ms time. For instance, a Controller with Controller ID 10 hex (16 dec) will reply a ‘10H’ at 16 x 5ms, that is 80ms.

- GLOBAL SUSPEND, Global command
  This command puts most Controllers within the Device to stop their operations and enter into suspend mode. Depending on the nature of the Controller, some Controllers will turn

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off the attached peripheral or some will finish the current event before entering into suspend mode. Refer to the respective Controller for details.

- USER SUSPEND, Controller command
  This command puts the respective Controller into suspend condition. Depending on the nature of the Controller, some Controllers will turn off the attached peripheral or will finish with the current operation before entering into suspend mode. Refer to the respective Controller for details.

3.0 CONTROLLERS OVERVIEW

IPC-3 has the following Controllers built in:

[Controller ID]	[Functions]
20 (hex)	General Purpose I/O port GPIO #1: 3 digital inputs and 3 digital outputs. This port can also be configured as Coin hopper control #1
21 (hex)	General Purpose I/O port GPIO #2: 3 digital inputs and 3 digital outputs. This port can also be configured as Coin hopper control #2
22 (hex)	General Purpose I/O port GPIO #3: 3 digital inputs and 3 digital outputs. This port can also be configured as Coin hopper control #3
23 (hex)	General Purpose I/O port GPIO #4: 3 digital inputs and 3 digital outputs. This port can also be configured as Coin hopper control #4
25 (hex)	General Purpose Analog port: 4 analog ADC inputs.

Controller 20 (hex) to 23 (hex) is a bank of 4 digital I/O ports providing a total of 12 digital inputs and 12 digital outputs. Each port can be configured as a GPIO or a Hopper control independently.

3.1 Controller 20 (hex) to 23 (hex) configured as GPIO

When configured as a GPIO, this Controller provides 3 digital inputs and 3 digital outputs. Functions of each input and output are identical (except Controller 23 that has double current capacity) and work independently.

[Digital Input]

This is an Active Low input. Input voltage < 3.5V will set active state (bit=1). A voltage > 4.5V or a floating input gives an inactive state (bit=0). Each input report is a rolling record of a continuous 1.28seconds. That means, any event happened in the past 1.28seconds would be logged and reported in a subsequent data retrieval command. With this history report like this, user can easily monitor a fast changing digital signal at a much moderate rate of data retrieval. Applications like selection buttons, mechanical / optical switches or sensor inputs are handy in this case.

The input is sampled at every 20ms and 2 consecutive samples give one record (bit). Thus each record equals 40ms. Either one or both of the two samples of a record is active will set that record active (bit=1). When both samples are inactive, the record is set inactive (bit=0). A quick

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computation of 1.28seconds = 40ms x 32bits. In another words, every input has 4 bytes of data to represent a history of 1.28seconds.
Record period = 1.28s; Record rate = every 40ms; Sampling rate = 20ms (frequency = 50Hz)
User has an option to clear this record on every data retrieval or to leave it in a rolling manner.

[Digital Output]

Each output consists of an optional 10K ohm pull up resistor to power positive and an active low darlington transistor open collector output. General latency is about 10ms. Max voltage = 24VDC or power positive, whichever is lower.
Each output of Controller 20 (hex) to 22 (hex) can sink current up to 500mA. And each output of Controller 23 (hex) can sink current up to 1000mA. Any of these outputs can be tied together to provide larger current sink provided that they are programmed to give the same output state. Each output has a built in ESD protection circuit and reverse inrush diode for inductive loads. Thus they can direct drive DC motors, solenoids, relays, lamps, etc.
All GPIO outputs have the following default stages after reset:

Output 1	Output 2	Output 3
Active	Inactive	Inactive
Logic Low	Logic High	Logic High

3.2 Controller 20 (hex) to 23 (hex) configured as Coin Hopper Control

When configured as a Coin Hopper Control, this Controller provides both the power and control signal to a MoneyControls MK4 Mode 2 compatible (pulse or parallel mode) coin hopper.

There are 4 operation modes defined in a MK4 compatible coin hopper.

Namely,	Mode 0	Direct Switching
	Mode 1	Logic Control
	Mode 2	Pulse Counting
	Reset	Hopper Reset

IPC supports Mode 2 and Reset modes only. When using with a mini hopper that has a 10-way IDC connector, the operation mode is fixed to Pulse Counting and no selection pin is provided.

MK4 compatible

Mini hopper

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Below signal names are given in a coin hopper perspective.

[Mode selection; IN1 and IN2]

The hopper will pay out a coin for every pulse it receives on IN3. At Controller reset, IN1 and IN2 are held at Reset mode for approximately 120ms. Any current operation of the hopper will cease and hopper will return to its reset state. After initial 120ms, Controller will then set the hopper to Mode 2 operation. IN1 and IN2 follow below function table.

Mode	IN1	IN2
2	1	0
Reset	0	1

[Pulse input; IN3]

A pulse is defined as a falling edge followed by a rising edge. Pulse given out at IN3 has a 80ms (logic low) active time and a 80ms inactive time (logic high). Each pulse represents a coin to be dispensed from the hopper.

[Low Level Sensor]

This pin connects to hopper low level sensor (or sense plate). When enough coins are present, this pin stays at low level (active), LOW=ON state. When not enough coins are present, this pin stays at high level (inactive), LOW=OFF state.
Note: some hopper models may have this signal logic reversed.

[Coin Exit Sensor]

This pin connects to coin hopper exit sensor. This is a feedback signal of IPC to count the number of coins has been dispensed. While IPC strives to measure every coin output, there are chances that noise or signal integrity jeopardizing the actual counting. Refer to *Busy* signal for details.

[Failure / Security]

This pin connects to hopper security / failure output. In normal operation when there is no failure, this pin stays at low level (active), ERR=ON state. When a fault is detected, this pin stays at high level (inactive), ERR=OFF state.
Note: some hopper models may have this signal logic reversed.

[High Level Sensor]

IPC does not provide this signal.

Other coin hopper functions

[Hopper Reset]

A command to reset Controller and hopper. Initialize sequence follows *Mode Selection: IN1 and IN2.*

[Dispense Coins]

A command to hopper for coin dispense. If hopper is still dispensing coins from previous command, this command adds to the total counts of coin dispensing. MK4 has a coin register that can hold 4095 counts. Refer to your hopper manual for the maximum allowable value.

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[Coin Meter]

A record of number of coins been dispensed. User can use this value to determine operation and functional correctness of the hopper. This meter max out at 65535. It should be cleared by *Coin Meter Reset* command. Refer to *Busy* section for precaution.

[Coin Meter Reset]

This command resets the *Coin Meter* to zero. Use this command at user discretion.

[Busy]

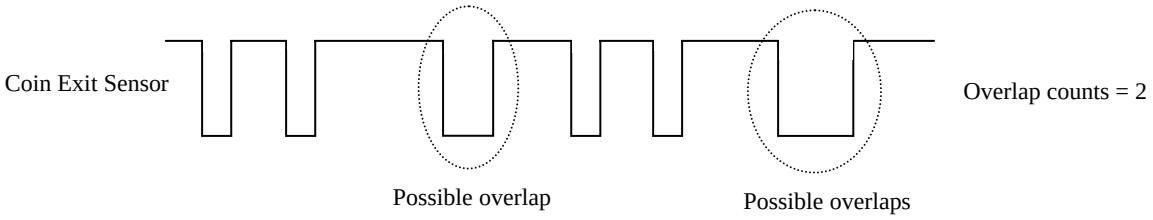
IPC compares number of coins user requests to dispense and number of coins has already been dispensed *(Coin Meter)*. If these two numbers do not match, the *Busy* signal is set.
Every coin output of the hopper is monitored by IPC via the *Coin Exit Sensor*. This sensor is usually the direct output of an optical sensor or a mechanical switch locating inside the hopper at the coin exit gate. The signal speed (duty cycle) is determined by the rotate disc slot size, speed of motor and the diameter of the coin.

Precautions
While IPC strives to measure every change of the *Coin Exit Sensor*, inaccuracy may exist due to noise and signal speed. In addition, if a wrong rotate disc is used, coins overlapping may occur. This will affect *Coin Meter* counts. Refer to *Overlap Counts* for overlapped solution.
If this is the case, *Busy* signal and *Coin Meter* may not reflect the real situation of the hopper. User should use caution when designing his system. Always contact your hopper manufacturer for the correct disc size.

Rotate disc slot too big for small coins causing coin overlap

[Overlap counts]

IPC provides a coin overlapping counter for each hopper ports to detect number of possible coin overlaps. This is carried out by a time comparator comparing the average coin exit time and any sudden change. If a longer exit time frame exists, there may be two or more small coins overlapping or cascading together in one disc slot. This will fool the *Coin Exit Sensor* resulting in a wrong *Coin Meter* counts.



This counter gives the number possible ‘wrong’ time frames during dispensing. Use *Coin Meter Reset* or *Hopper Reset* to clear counter.

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3.3 Controller 25 (hex) Analog inputs

This Controller provides 4 analog ADC inputs. Each ADC is an analog-to-digital converter providing a 8-bit resolution, dividing 5VDC into 255 steps. Thus each step equals 0.0196VDC. In theory accuracy is close to 0.0049VDC. But user should take account for power / white noise and input impedance, etc. Total conversion time of the 4 ADCs is about 250us.

This Controller is particular useful in applications like
Temperature sensor (thermistor), thermostat, joystick VR, analog pressure sensor, etc.

4.0 HARDWARE

An outlook of IPC-3 device box.

4.1 LED Patterns

IPC provides 4 status LEDs for user to diagnose with his system. They are the:

[POWER]	Turns on when IPC connects to power
[USB COMMS]	Blinks when USB activities TX and RX are undergoing
[INPUT / COINS]	Flashes when IPC receives an input signal
[OUTPUT / CONTROL]	Flashes when IPC sends an output signal or ADC samples

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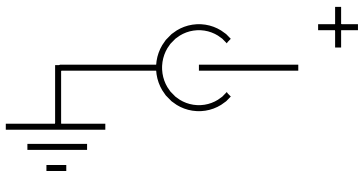
4.2 Electrical Hookups

IPC-3 has a POWER PORT, USB PORT, a bank of 4 DIGITAL I/O & HOPPER PORTS and an ANALOG INPUT PORT.

4 DIGITAL I/O & HOPPER PORTS

ANALOG INPUT PORT POWER PORT USB PORT

4.3 POWER PORT 12-24VDC only, 3Amp max



This port is a center positive power plug with a 2.1mm center pin. Connect power to this port for IPC and attached peripheral(s) on Digital I/O & Hopper ports. Refer to peripheral user manual for correct voltage. Max voltage = 24VDC.

This port is protected by a slow blow fuse of maximum 3A DC current. Should you require a higher power for your peripheral(s), use separate wiring method for other power supply source.

4.4 USB PORT

This is a USB 2.0, type B full speed port. Connects this port to a PC root hub or a USB hub. Use only USB 2.0 capable cable. For less noise connection, always connects to PC root hub found on the back of PC (direct to motherboard).

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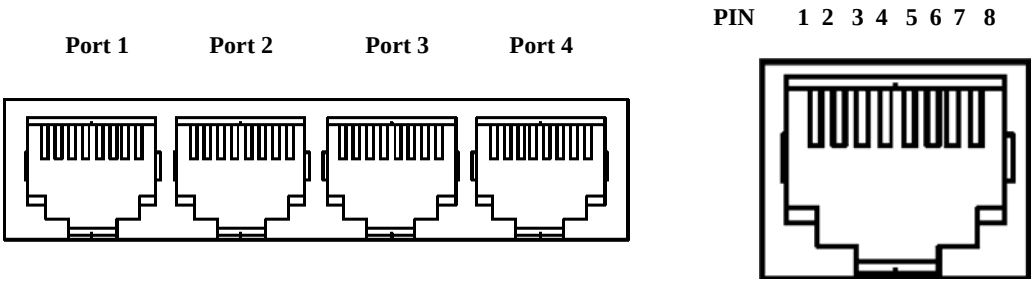
4.5 DIGITAL I/O & HOPPER PORTS

A bank of 4 generic RJ-45 8 position ports; Mated with RJ-45 8 position connector.

Warning: These are NOT PC network ports. Do not connect to PC network.



Port 1 to Port 3	Max Power = 24VDC 1500mA
	Max Output sink = 500mA per channel; Inductive loading okay.
Port 4	Max Power = 24VDC 1500mA
	Max Output sink = 1000mA per channel; Inductive loading okay.

Note: At no time should the total current from all ports exceed 3Amp. Otherwise internal protective fuse will blow.

Optional Pull Up resistor function for all GPIO outputs

There is a 30k ohm resistor on each digital output ports connecting to PWR POS via a jumper option. By default, this jumper is closed. Providing a pull up resistor function to all output ports. If there is a situation where this function is not desired, simply remove the jumper shunt and make this connection open.

Locate the J5 jumper on the printed circuit board. This jumper provides a global pull up function to all output ports.

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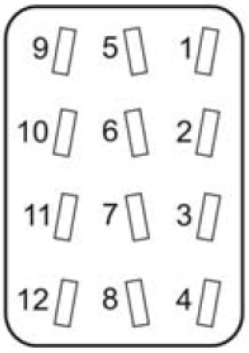
When configured as a Hopper Control.

MK 4 compatible Universal Hopper

RJ-45 CONNECTOR	TYPE	HOPPER FUNCTION	HOPPER CINCH CONNECTOR
PIN 1	Output	IN3, Pulse input	PIN 12
PIN 2	Input	Coin Exit Sensor	PIN 3
PIN 3	Power	Power / Logic Positive	PIN 9* , PIN 10
PIN 4	Output	IN1, Mode input	PIN 4
PIN 5	Output	IN2, Mode input	PIN 8
PIN 6	Power	Power / Logic Negative	PIN 1* , PIN 2
PIN 7	Input	Security / Failure	PIN 5
PIN 8	Input	Low Level Sensor	PIN 7

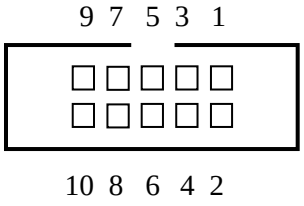


Note * If hopper requires more power than the port can provide or a less noise operation is needed, connects PIN 9 (Power Positive) and PIN 1 (Power Negative) to a separate power source.

<- Viewing towards hopper 12 pin cinch connector.
(Contact us for a Cinch connection to RJ-45 modular jack conversion option)

Compact Mini Hopper

RJ-45 CONNECTOR	TYPE	HOPPER FUNCTION	HOPPER 10-WAY IDC CONNECTOR
PIN 1	Output	IN3, Pulse input	PIN 7
PIN 2	Input	Coin Exit Sensor	PIN 9
PIN 3	Power	Power / Logic Positive	PIN 1 or PIN 2 or PIN 3
PIN 4	Output	N/A	N/A
PIN 5	Output	N/A	N/A
PIN 6	Power	Power / Logic Negative	PIN 4 or PIN 5 or PIN 6
PIN 7	Input	Security / Failure	PIN 8
PIN 8	Input	Low Level Sensor	PIN 10



<- Viewing towards hopper 10-way IDC connector

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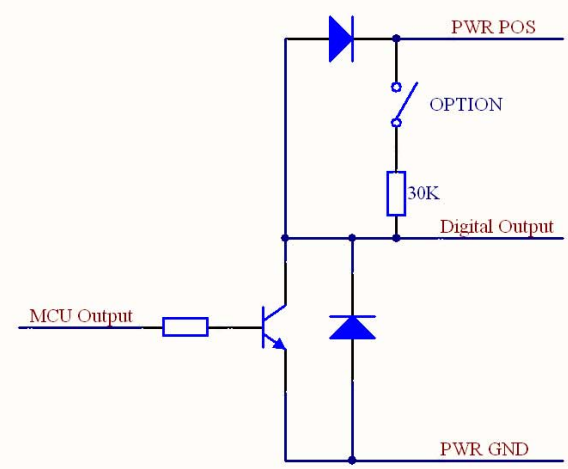
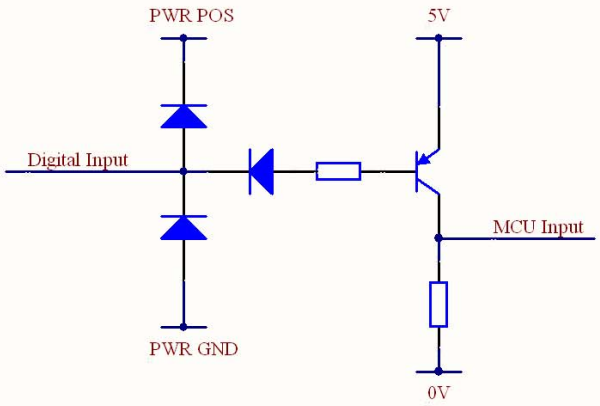
When configured as a GPIO

RJ-45 CONNECTOR	TYPE	GPIO FUNCTION
PIN 1	Output	Digital Output 3
PIN 2	Input	Digital Input 1
PIN 3	Power	Power Positive
PIN 4	Output	Digital Output 1
PIN 5	Output	Digital Output 2
PIN 6	Power	Power Negative
PIN 7	Input	Digital Input 2
PIN 8	Input	Digital Input 3

Interface circuit illustration



Digital Output circuit



Digital Input circuit

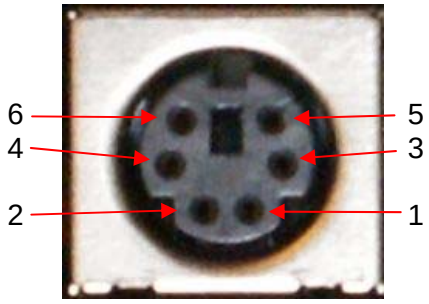
4.6 ANALOG PORT

Generic PS/2 6 position socket; Mated with generic PS/2 6 position connector

The port provides voltage reference lines and 4 analog ADC inputs

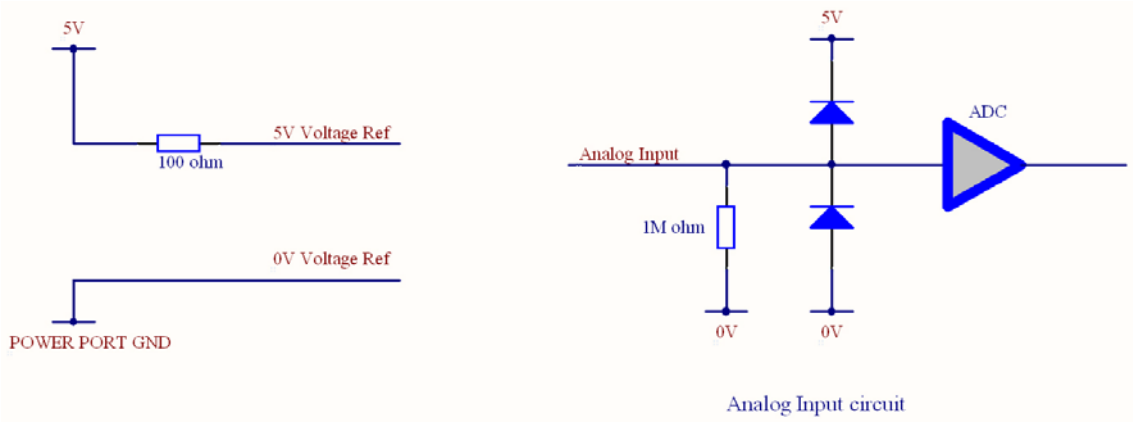
Connector Pin-out:

PIN 1 - 5V voltage reference, 100 ohm inline resistor to Vcc
PIN 2 – ADC #1
PIN 3 – ADC #2
PIN 4 – ADC #3
PIN 5 – ADC #4
PIN 6 – 0V voltage reference, connects to Power Ground



Looking toward connector

Interface circuit illustration



Analog Input circuit

5.0 CE Declaration of Conformity

We certify that this product complies with the requirements of the EC Council Directive on electromagnetic compatibility 2004/108/EC

Applicable Standards with amendments:
EN55022: 2006
EN55024: 1998 +A1: 2001 +A2: 2003
EN61000-3-2: 2006
EN61000-3-3: 1995 +A1: 2001 +A2: 2005

Electrostatic Discharge Precaution:
The normal function of the device may be disrupted by a strong electromagnetic interference. If so, simply reset the device by cycling the power. Normal operation should be resumed. If in such a case that the function could not be resumed, relocate the device to another ESD-safe location.

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